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U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, D. C. 20555-0001

Joseph M. Farley Nuclear Plant
Response to Generic Letter 92-01, Revision 1, Supplement 1
Reactor Vessel Structural Integrity

Ladies and Gentlemen:

The NRC issued Generic Letter 92-01, Revision 1, Supplement 1 (GL92-01, R1, S1), Reactor Vessel Structural Integrity, on May 19, 1995. In the generic letter supplement, the NRC identified a concern that licensees may not have all of the relevant data pertinent to the evaluation of the structural integrity of their reactor pressure vessels. The generic letter supplement requested licensees to respond within 90 days describing those actions taken or planned to locate all data relevant to the determination of reactor vessel integrity, or an explanation of why the existing data is considered complete as previously submitted.

Additionally, GL92-01, R1, S1 requested licensees to provide the following information within 6 months of the date of the generic letter supplement:

- an assessment of any change in best-estimate chemistry based on consideration of all relevant data;
- a determination regarding the need to use the ratio procedure described in Position 2.1 of Regulatory Guide 1.99, Revision 2; and
- a written report providing any newly acquired data and; (a) the results of any necessary revisions to the evaluation of RPV integrity in accordance with the requirements of 10 CFR 50.60, 10 CFR 50.61, Appendices G and H to 10 CFR 50, and any potential impact on the LTOP or P-T limits or (b) a certification that all information previously submitted remains valid.

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Southern Nuclear Operating Company (SNC) letter to the NRC, dated August 9, 1995, provided the 90 day response to GL92-01, R1, S1, for Farley 1 and 2. Attachments 1 and 2 to this letter provide the 6 month response to GL92-01, R1, S1 for Farley 1 and 2. Based on the specific NRC inquiries contained in GL92-01, R1, S1, SNC has focused the activities associated with this response to those necessary to address weld chemistry variability.

In summary, the Farley 1 and 2 reactor vessel beltline welds were fabricated using both copper and non-copper weld wire. Additional information obtained through participation in the Combustion Engineering Reactor Vessel Group (CE-RVG) and discussions with plants containing the same weld filler material heat numbers resulted in slight changes to the best-estimate copper and nickel values for the Farley 1 and 2 beltline welds. However, the changes to the best estimate copper and nickel values, and the corresponding changes to the chemistry factors determined in accordance with 10 CFR 50.61, do not result in the Farley 1 and 2 beltline welds becoming the limiting beltline material. Additionally, the changes to the best-estimate copper and nickel do not result in a projected end-of-life upper shelf energy less than 50 ft-lbs for any beltline material. Therefore, the current Farley 1 and 2 reactor vessel integrity analyses remain valid.

As part of a long-term resolution of this issue, SNC is currently participating in the Combustion Engineering Owners Group - Reactor Vessel Working Group (CEOG-RVWG) weld chemistry variability task. The objective of this task is to determine best-estimate copper and nickel values for each weld material heat used in the beltline region of CE-fabricated reactor vessels. Completion of this task is currently projected to require a minimum of 18 months. Upon completion, the results of this task will be evaluated to determine the affect of any new information on the reactor vessel integrity analyses for Farley 1 and 2.

Should you have any questions, please advise.

Respectfully Submitted,
SOUTHERN NUCLEAR OPERATING COMPANY

DO Morey

Dave Morey

SWORN TO AND SUBSCRIBED BEFORE ME
THIS 16th DAY OF November, 1995

Carol Louise Taylor
Notary Public

My Commission Expires: June 24, 1997

DNM/TWS
Attachments

cc: Southern Nuclear Operating Company
R. D. Hill, Plant Manager

U. S. Nuclear Regulatory Commission, Washington, DC
B. L. Siegel, Licensing Project Manager, NRR

U. S. Nuclear Regulatory Commission, Region II
S. D. Ebneter, Regional Administrator
T. M. Ross, Senior Resident Inspector

ATTACHMENT 1

Response to Generic Letter 92-01, Revision 1, Supplement 1

Requested Information

Joseph M. Farley Nuclear Plant
Units 1 and 2

Requested Information

(1) Describe those actions taken or planned to locate all data relevant to the determination of reactor vessel integrity, or an explanation of why the existing data is considered complete as previously submitted.

The response to this item was provided in SNC letter to the NRC dated August 9, 1995.

(2) an assessment of any change in best-estimate chemistry based on consideration of all relevant data;

Tables 1 and 2 below provide the best-estimate chemistry values for the Farley 1 and 2 reactor vessel beltline welds based on the information contained in Attachment 2. It should be noted that some of the values contained in the NRC-RVID do not match the values provided by SNC in response to GL92-01, R1. Additionally, SNC submitted WCAP-14197, Evaluation of Pressurized Thermal Shock for Farley Units 1 & 2, to the NRC on March 7, 1995. This submittal included revised PTS values for Farley 1 and 2, including changes to the calculated chemistry factors, subsequent to the GL92-01, R1, response. The chemistry factors (CF) provided in Table 1 and 2 below, based on the SNC response to GL92-01, R1, or WCAP-14197, as appropriate, demonstrate the impact of the revised best-estimate copper and nickel values determined in response to GL92-01, R1, S1.

As shown in Table 1, the revised best-estimate copper and nickel values for Farley 1 resulted in an increased CF, determined in accordance with 10 CFR 50.61, for lower shell axial seams 20-894A and 20-894B. The CF increase from 92°F to 104°F for seams 20-894A and 20-894B does not result in either of these seams becoming the limiting beltline material for Farley 1.

Table 2 provides changes to the best-estimate copper and nickel values for the Farley 2 beltline weld seams. As shown in Table 2, the changes to the best-estimate copper and nickel values do not result in an increased CF for any of the beltline weld seams.

SEAM NUMBER	LOCATION	HEAT NO.	GL 92-01 REVISION 1 [1]			GL 92-01, REVISION 1, SUPPLEMENT 1		
			Cu	Ni	CF	Cu	Ni	CF
11-894	Middle to Lower Shell Circ. Weld	6329637	0.225	0.20	114.5[2]	0.21	0.11	100.8
19-894A	Middle Shell Axial Seam A	33A277	0.25	0.21	74.9[3]	0.24	0.17	74.9[3]
19-894B	Middle Shell Axial Seam B	33A277	0.25	0.21	74.9[3]	0.24	0.17	74.9[3]
20-894A	Lower Shell Axial Seam A	90099	0.17	0.20	92.0	0.20	0.20	104
20-894B	Lower Shell Axial Seam B	90099	0.17	0.20	92.0	0.20	0.20	104
Surv. Weld	Surveillance Test Plate/Weld	33A277	[4]	[4]	74.9[3]	0.24	0.17	74.9[3]

Table 1 - Best-Estimate Chemistry Changes for Farley 1

Notes: [1] Unless otherwise noted

[2] SNC reported CF=114.5°F in response to GL92-01, R1. RVID indicates CF=117.0°F

[3] SNC reported CF=78.689°F in response to GL92-01, R1. RVID indicates CF=78.60°F. These values have been superseded by Westinghouse report WCAP-14197 transmitted to NRC by SNC letter dated March 7, 1995. Based on credible surveillance data, CF=74.9°F.

[4] Best-estimate copper and nickel values not provided for surveillance weld in GL92-01, R1 response.

SEAM NUMBER	LOCATION	HEAT NO.	GL 92-01 REVISION 1[1]			GL 92-01, REVISION 1, SUPPLEMENT 1		
			Cu	Ni	CF	Cu	Ni	CF
11-923	Middle to Lower Shell Circ. Weld	5P5622	0.13	0.20	76.0	0.14	0.07	67.3
19-923A	Middle Shell Axial Seam A	BOLA	[2]	[2]	[2]	0.03	0.91	8.9[3]
	Middle Shell Axial Seam A	HODA	0.02	0.96	27[4]	0.02	0.96	27[4]
19-923B	Middle Shell Axial Seam B	BOLA	0.02	0.93	8.9[3]	0.03	0.91	8.9[3]
20-923A	Lower Shell Axial Seam A	83640	0.05	0.20	49.0	0.05	0.07	34.05
20-923B	Lower Shell Axial Seam B	83640	0.05	0.20	49.0	0.05	0.07	34.05
Surv. Weld	Surveillance Test Plate/Weld	BOLA	[5]	[5]	[5]	0.03	0.91	8.9[3]

Table 2 - Best-Estimate Chemistry Changes for Farley 2

Notes:

[1] Unless otherwise noted.

[2] Heat BOLA was not identified by SNC GL92-01, R1 response as part of weld seam 19-923A.

[3] SNC reported CF=10.01°F for weld heat BOLA in response to GL92-01, R1. RVID indicates CF=8.94°F. These values have been superseded by Westinghouse report WCAP-14197 transmitted to NRC by SNC letter dated March 7, 1995. Based on credible surveillance data, the calculated CF is 8.9°F.

[4] SNC response to GL92-01, R1 indicated a calculated CF of 10.01°F for seam 19-923A. However, the surveillance material for Unit 2 is heat BOLA and the CF calculated for heat BOLA is not directly applicable to welds containing heat HODA. Due to the availability of credible surveillance data for heat BOLA and a corresponding calculated chemistry factor of 8.9°F, the CF for seam 19-923A is conservatively taken as 27°F based on the copper and nickel content of heat HODA. Therefore, the correct CF for seam 19-923A is 27.0°F as reported in WCAP 14197, transmitted to the NRC by SNC letter dated March 7, 1995.

[5] Best-estimate copper and nickel values not provided for surveillance weld in GL92-01, R1 response.

(3) a determination regarding the need to use the ratio procedure described in Position 2.1 of Regulatory Guide 1.99, Revision 2; and

The surveillance program weld for Farley 1 was fabricated using the same heat of weld wire used to fabricate middle shell axial seams 19-894A and 19-894B (heat 33A277). Although these welds were fabricated using copper coated weld wire, it is expected that chemical analyses performed through the complete thickness of the surveillance weld would exhibit a copper variability similar to that expected in the reactor vessel weld seams. Therefore, the results of mechanical property tests performed on the surveillance weld are considered to be representative of the property changes expected in the reactor vessel beltline seams.

For Farley 2, the surveillance program weld was fabricated using the shielded metal arc welding process and E8018 stick electrodes, in a manner similar to that used to fabricate middle shell axial seams 19-923A and 19-923B (heat BOLA). These electrodes were not copper coated and do not exhibit the chemical variability found in copper coated submerged arc weld wire. Therefore, results of mechanical property tests performed on the surveillance weld are considered to be representative of changes expected in the reactor vessel beltline seams.

As stated above, the best-estimate copper and nickel content for the Farley 1 and 2 surveillance program welds are considered to be representative of their respective beltline welds. Therefore, it is not necessary to adjust the surveillance weld results using the ratio procedure described in Position 2.1 of Regulatory Guide 1.99, Revision 2.

(4) a written report providing any newly acquired data and; (a) the results of any necessary revisions to the evaluation of RPV integrity in accordance with the requirements of 10 CFR 50.60, 10 CFR 50.61, Appendices G and H to 10 CFR 50, and any potential impact on the LTOP or P-T limits or (b) a certification that all information previously submitted remains valid.

Attachment 2 provides the newly acquired data requested by GL92-01, R1, S1. The increased chemistry factors stated in response to NRC requested information item 2, do not result in any of the Farley 1 and 2 beltline welds becoming the limiting material with regard to reactor vessel integrity. Therefore, the current reactor vessel integrity analyses for Farley 1 and 2 continues to remain valid.

ATTACHMENT 2

Best-Estimate Copper and Nickel Values for Reactor Vessel Beltline Welds

Joseph M. Farley Nuclear Plant
Units 1 and 2

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Appendices

Purpose

This report provides the best-estimate copper and nickel values for the beltline materials contained in the Farley 1 and 2 reactor vessels to support the Southern Nuclear Operating Company (SNC) response to Generic Letter 92-01, Revision 1, Supplement 1.

Scope

1. Collection of information impacting the best-estimate copper and nickel values for Farley 1 and 2 reactor vessel beltline welds; and
2. Determination of the best-estimate copper and nickel value for Farley 1 and 2 beltline welds.

Summary

Table 1 provides the best-estimate copper and nickel content for the primary weld filler material heat numbers contained in the beltline region of the Farley 1 and 2 reactor vessels.

Plant	Heat Number	Wt % Copper	Wt % Nickel	Reference
Farley 1	33A277	0.24	0.17	Table A-1
	6329637	0.21	0.11	Table A-3
	90099	0.20	0.20	Table A-5
Farley 2	5P5622	0.14	0.07	Table A-2
	83640	0.05	0.07	Table A-4
	BOLA	0.03	0.91	Table A-6
	HODA	0.02	0.96	Table A-7

Table 1 - Best-Estimate Values for Weld Filler Material Heats Contained in Farley 1 and 2 Reactor Vessel Beltlines

Background

The Farley 1 and 2 reactor vessels were fabricated by Combustion Engineering's Nuclear Division in Chattanooga, Tennessee. Although the plates for the Farley Unit 1 vessel were originally purchased by Babcock and Wilcox, they were eventually transferred to the Combustion Engineering facility for welding and completion of the fabrication process.

SNC participated in the Combustion Engineering - Reactor Vessel Group (CE-RVG) Phase II activity, which included a review of the original fabrication records for the Farley 1 and 2 reactor vessels. As a result, pertinent information abstracted from the original fabrication records, along with copies of the original fabrication records, were provided to SNC. These records are the primary source of information incorporated into this report.

As part of the fabrication process, Combustion Engineering (C-E) completed a Weld Inspection Form (WIF) for each weld seam contained in a specific reactor vessel. The WIF identified the seam identification number, the consumables used to fabricate the weld (i.e., weld wire heat number, flux type, and flux lot), weld procedure, and heat treatment procedures. It should be noted that seam numbers were often assigned to, and WIFs completed for, welds in surveillance test plates that were later provided for use in the reactor vessel surveillance program.

Combustion Engineering used two primary weld processes to fabricate welds for the Farley 1 and 2 reactor vessel beltline seams. These are shielded metal arc welds (SMAW) and submerged arc welds (SAW). Shielded metal arc welds were made using E8018 stick electrodes and were used primarily for (1) fit-up of the plates in preparation for submerged arc welding; (2) to fill in backgrooves following removal of backing rings; and (3) miscellaneous weld repairs. When used for fit-up purposes, the shielded metal arc weld material was typically removed and replaced by a submerged arc weld. However, the full thickness of the middle shell axial welds for Farley 2 was fabricated using the shielded metal arc welding process.

Submerged arc welds were fabricated using a machine process that involved a continuous feed of weld wire from large spools into the weld puddle, which was shielded by a blanket of powdered material called flux. Submerged arc welds were fabricated using either one or two continuous weld wires fed from spools containing approximately 120 pounds of weld wire each. Submerged arc welds fabricated using only one weld wire are called single arc welds and those fabricated by feeding two weld wires into the weld puddle are called tandem arc welds.

The weld wires that were used to fabricate submerged arc welds typically fall into two categories for the purpose of determining the best-estimate copper and nickel content. These are copper coated and non-copper coated wires. The copper coating was applied to the weld wire after the weld wire manufacturer performed the necessary chemical analyses to verify compliance with the applicable material specification. The purpose of the copper coating was to prevent corrosion of the wire prior to use. After copper was identified as the greatest contributor to radiation embrittlement damage, the practice of coating the weld wire with copper was discontinued. The Farley 1 and 2 reactor vessel beltline welds were fabricated using both copper coated and non-copper coated weld wires.

There are typically five types of chemical analyses that were performed on weld filler material contained in reactor pressure vessels. These are described in Table 2.

ANALYSIS TYPE	DESCRIPTION
Bare Wire Chemical Analysis (BWCA)	Chemical analysis performed either prior to application of the copper-coating to the weld wire or following removal of the copper coating for the test specimen. This analysis does not account for the number of electrodes used in the weld process (i.e., single or tandem arc), the copper coating applied to the weld wire, or the flux type/lot used to fabricate a specific weld.
Coated Electrode Deposit Chemistry (CEDC)	Chemical analysis of welds fabricated using stick electrodes in the as-deposited condition (i.e., SMAW).
In-Process Weld Deposit Analysis (IPWDA)	Chemical analysis of chip samples taken directly from the vessel weld. IPWDA generally represents a weld/flux deposit chemistry or a coated electrode deposit chemistry for the specific weld seam.
Surveillance Welds	Chemical analysis of surveillance capsule weld specimen. Chemical analyses of surveillance welds are typically performed on irradiated specimens and are similar to other as-deposited chemical analyses in that they account for the consumables and number of electrodes used in the welding process.
Weld Flux Deposit Chemistry (WFDC)	Chemical analysis of weld material in an as-welded condition. WFDC include the effects of the consumables used in fabrication of the specific weld on which the analysis was performed.

Table 2: Types of Chemical Analyses Performed

Methodology

SNC reviewed the WIFs for the reactor vessel beltline seams for Farley 1 and 2, including welds in surveillance test plates, and identified the heat numbers of the weld filler material used to fabricate the beltline and surveillance welds. Tables 3 and 4 contain a list of all consumables used in the fabrication of the Farley 1 and 2 reactor vessel beltline welds, respectively.

SEAM NUMBER	WELD LOCATION	HEAT NUMBER(S)		FLUX		REFERENCE
				TYPE	LOT	
11-894	Middle to Lower Shell Circ. Weld	6329637	[1]	0091	3999	RVG-0000002963
	Fit-up/Backgroove Weld	FOCA[2]	[3]	[4]	[4]	RVG-0000002963
	Fit-up/Backgroove Weld	FOAA[2]	[3]	[4]	[4]	RVG-0000002963
	Repair Weld	BOLA[2]	[3]	[4]	[4]	RVG-0000002962
19-894A	Middle Shell Axial Seam A	33A277	33A277	1092	3889	RVG-0000002949
	Fit-up/Backgroove Weld	DBIJ[2]	[3]	[4]	[4]	RVG-0000002949
19-894B	Middle Shell Axial Seam B	33A277	33A277	1092	3889	RVG-0000002948
	Fit-up/Backgroove Weld	EODJ[2]	[3]	[4]	[4]	RVG-0000002948
20-894A	Lower Shell Axial Seam A	90099	90099	0091	3977	RVG-0000002947
	Fit-up/Backgroove Weld	ICJJ[2]	[3]	[4]	[4]	RVG-0000002947
	Fit-up/Backgroove Weld	IOBJ[2]	[3]	[4]	[4]	RVG-0000002947
	Repair Weld	KBEJ[2]	[3]	[4]	[4]	RVG-0000002944
	Repair Weld	JADJ[2]	[3]	[4]	[4]	RVG-0000002944
20-894B	Lower Shell Axial Seam B	90099	90099	0091	3977	RVG-0000002946
	Fit-up/Backgroove Weld	GBCJ[2]	[3]	[4]	[4]	RVG-0000002946
	Repair Weld	KBEJ[2]	[3]	[4]	[4]	RVG-0000002944
	Repair Weld	JADJ[2]	[3]	[4]	[4]	RVG-0000002944
Surv. Weld	Surveillance Test Plate/Weld	33A277	33A277	0091	3922	RVG-0000002441

TABLE 3 - FARLEY UNIT 1 BELTLINE WELD CONSUMABLES

NOTES: [1] Listing of a single heat number indicates single arc weld. Therefore, second heat number is not applicable.
[2] E8018 filler material
[3] Multiple electrodes are not applicable to Shielded Metal Arc Welds.
[4] Powdered flux is not applicable to Shielded Metal Arc Welds.

SEAM NUMBER	WELD LOCATION	HEAT NUMBER(S)		FLUX TYPE	FLUX LOT	REFERENCE
	Middle to Lower Shell Circ. Weld	5P5622	[1]	0091	1122	RVG-0000003881
11-923	Fit-up/Backgroove Weld	GACJC[2]	[3]	[4]	[4]	RVG-0000003881
	Repair Weld	HABJC[2]	[3]	[4]	[4]	RVG-0000003882
19-923A	Middle Shell Axial Seam A	BOLA[2]	[3]	[4]	[4]	RVG-0000003903
	Middle Shell Axial Seam A	HODA[2]	[3]	[4]	[4]	RVG-0000003903
	Middle Shell Axial Seam B	BOLA[2]	[3]	[4]	[4]	RVG-0000003902
19-923B	Repair Weld	HABJC[2]	[3]	[4]	[4]	RVG-0000003904
	Repair Weld	CBGC[2]	[3]	[4]	[4]	RVG-0000003905
	Repair Weld	JAOIC[2]	[3]	[4]	[4]	RVG-0000003905
	Lower Shell Axial Seam A	83640	[1]	0091	3490	RVG-0000003906
	Fit-up/Backgroove Weld	ABEA[2]	[3]	[4]	[4]	RVG-0000003906
20-923A	Repair Weld	IAGA[2]	[3]	[4]	[4]	RVG-0000003907
	Repair Weld	EOBC[2]	[3]	[4]	[4]	RVG-0000003908
	Lower Shell Axial Seam B	83640	[1]	0091	3490	RVG-0000003909
	Fit-up/Backgroove Weld	ABEA[2]	[3]	[4]	[4]	RVG-0000003909
20-923B	Fit-up/Backgroove Weld	BOLA[2]	[3]	[4]	[4]	RVG-0000003909
	Repair Weld	IAGA[2]	[3]	[4]	[4]	RVG-0000003910
Surv. Weld	Surveillance Test Plate/Weld	BOLA[2]	[3]	[4]	[4]	RVG-0000004043

TABLE 4 - FARLEY UNIT 2 BELTLINE WELD CONSUMABLES

NOTES: [1] Listing of a single heat number indicates single arc weld. Therefore, second heat number is not applicable.
[2] E8018 filler material
[3] Multiple electrodes are not applicable to Shielded Metal Arc Welds.
[4] Powdered flux is not applicable to Shielded Metal Arc Welds.

As stated previously, shielded metal arc welds using E8018 weld rods were generally used for fit-up and repair welds and are included on the WIF where applicable for a specific seam. For Farley 2, E8018 filler material was used to fabricate the full thickness of the middle shell axial welds. In the case of fit-up welds, the E8018 filler material was typically removed prior tc completion of the submerged arc welding process and therefore, does not contribute significantly to the copper and nickel content of the final weld. For weld repairs containing E8018 filler material, the repair typically represents a small fraction of the final weld volume. Additionally, E8018 filler material typically contained a very small amount of copper, in the range of 0.02 to 0.03 weight percent, and approximately 1.0 weight percent nickel. Due to the relatively limited volume of filler material contained in the weld repairs and the low copper content associated with E8018 filler material, the contribution of copper and nickel associated with the weld repair is not considered to have a significant impact on the best-estimate copper and nickel content of a particular weld seam. Tables 5 and 6 provide a list of primary weld filler material heat numbers used in the Farley 1 and 2 reactor vessels, respectively.

SEAM NUMBER	WELD LOCATION	HEAT NUMBER(S)		FLUX TYPE	FLUX LOT	REFERENCE
11-894	Middle to Lower Shell Circ. Weld	6329637	[1]	0091	3999	RVG-0000002963
19-894A	Middle Shell Axial Seam A	33A277	33A277	1092	3889	RVG-0000002949
19-894B	Middle Shell Axial Seam B	33A277	33A277	1092	3889	RVG-0000002948
20-894A	Lower Shell Axial Seam A	90099	90099	0091	3977	RVG-0000002947
20-894B	Lower Shell Axial Seam B	90099	90099	0091	3977	RVG-0000002946
Surv. Weld	Surveillance Test Plate/Weld	33A277	33A277	0091	3922	RVG-0000002441

TABLE 5 - FARLEY UNIT 1 PRIMARY BELTLINE WELD CONSUMABLES

NOTES: [1] Listing of a single heat number indicates single arc weld. Therefore, second heat number is not applicable.

SEAM NUMBER	WELD LOCATION	HEAT NUMBER(S)		FLUX TYPE	FLUX LOT	REFERENCE
11-923	Middle to Lower Shell Circ. Weld	5P5622	[1]	0091	1122	RVG-0000003881
19-923A	Middle Shell Axial Seam A	BOLA[2]	[3]	[4]	[4]	RVG-0000003903
	Middle Shell Axial Seam A	HODA[2]	[3]	[4]	[4]	RVG-0000003903
19-923B	Middle Shell Axial Seam B	BOLA[2]	[3]	[4]	[4]	RVG-0000003902
20-923A	Lower Shell Axial Seam A	83640	[1]	0091	3490	RVG-0000003906
20-923B	Lower Shell Axial Seam B	83640	[1]	0091	3490	RVG-0000003909
Surv. Weld	Surveillance Test Plate/Weld	BOLA[2]	[3]	[4]	[4]	RVG-0000004043

TABLE 6 - FARLEY UNIT 2 PRIMARY BELTLINE WELD CONSUMABLES

NOTES: [1] Listing of a single heat number indicates single arc weld. Therefore, second heat number is not applicable.
[2] E8018 filler material
[3] Multiple electrodes are not applicable to Shielded Metal Arc Welds.
[4] Powdered flux is not applicable to Shielded Metal Arc Welds.

The following databases were searched to identify the existence of chemical analyses for those weld material heats listed in Tables 5 and 6:

- Draft CE-RVG Phase II Reports (including PR-EDB)
- NRC Reactor Vessel Integrity Database (RVID)
- EPRI RMATCH
- EPRI PREP3
- Draft ATI/WOG RPVDATA

Individual discussions were held with plants containing the same weld filler material heats (i.e., sister plants) to share information and determine the existence of supplemental chemical testing that might have been performed. In instances where the chemical analysis for a particular weld filler material heat exactly matched the analysis reported by another source for all elements, they were considered to be duplicates of the same chemical analysis to avoid "double counting" a particular analysis. The information contained in the NRC-RVID was considered to be best-estimate licensing values reported by other utilities and use of this information was limited to identification of sister plants. For the same reason, information contained in RMATCH, PREP3, and RPVDATA that did not reference a specific analysis number or a specific test report was not included in the determination of the beltline weld best-estimate copper and nickel values.

Following collection of weld chemistry data, a weighted average methodology was used to determine the best-estimate copper and nickel content for the weld filler material heat numbers listed in Tables 5 and 6. The weighted average approach appropriately accounts for chemical analyses that were performed on tandem arc welds in the as-deposited condition. Chemical analyses of tandem arc welds are considered to represent an average chemistry of the two weld wires used to fabricate the weld. Accordingly, chemical analyses performed on tandem arc welds are counted twice in determination of the best-estimate copper and nickel values while chemical analyses performed on single arc welds are counted only once. This methodology is applicable to WFDCs, IPWDAs, and chemical analyses performed on surveillance welds. Although BWCAs are sometimes listed as being applicable to tandem arc welds, they represent an analysis that was performed on only a single wire or stick electrode and therefore, are only counted once in the best estimate copper and nickel determination.

Due to the copper coating applied to certain heats of weld wire used in the submerged arc process, the BWCA for copper coated weld wire were treated somewhat differently from welds fabricated using either non-copper coated weld wire or shielded metal arc electrodes. In the case of copper coated weld wire, the BWCA were performed on weld wire prior to coating with copper or with the copper coating removed. Therefore, BWCA do not accurately reflect the copper content of reactor vessel welds fabricated using copper coated electrodes and are not appropriate for use in determination of the best-estimate copper for copper coated electrodes. The nickel content of the weld wire was not significantly altered in the copper coating process and therefore, the BWCA are appropriate for use in determination of the best-estimate nickel value for copper coated weld wires.

BWCA performed on non-copper coated or shielded metal arc electrodes are representative of reactor vessel welds with regard to copper and nickel content. For this reason, BWCA are incorporated into the determination of best-estimate copper and nickel for welds fabricated using non-copper coated weld wire and shielded metal arc electrodes.

The copper coating applied to weld wire used for submerged arc welds varied primarily from spool to spool. Due to the limited number of wire spools used to fabricate surveillance welds, multiple chemical analyses performed on a single surveillance weld may not reflect the copper variation that may exist in the reactor vessel welds. In order to prevent a large number of chemical analyses performed on a single surveillance weld from skewing the best-estimate copper and nickel based solely on the number of chemical analyses performed, multiple chemical analyses performed on a single surveillance weld were averaged to determine a single value for the surveillance weld. The average for the surveillance weld was then factored into the weighted average based on whether it was a single or tandem arc weld. This approach is used only for welds fabricated using copper coated weld wires.

Chemical analyses performed on surveillance welds fabricated using non-copper coated weld wires or shielded metal arc electrodes are not expected to demonstrate the copper variability exhibited by those fabricated using copper coated wire. Therefore, multiple chemical analyses performed on a single surveillance weld fabricated using non-copper coated weld wire or shielded metal arc electrodes are considered to be unique analyses instead of duplicates of the same analysis. In determination of the best-estimate copper and nickel value for a non-copper coated weld wire, chemical analyses performed on surveillance weld filler material are weighted as indicated in Table 7 based on whether the surveillance weld was fabricated using tandem or single submerged arc welding process. It should be noted that the copper and nickel values for surveillance welds fabricated using non-copper coated weld wire are not averaged prior to applying the weighting factors in Table 7.

Table 7 illustrates the weighting factors used to determine the best-estimate copper and nickel content of the beltline welds.

Analysis Type	Wire Type/Weld Configuration							
	Copper Coated				Non-Copper Coated			
	Single Arc		Tandem Arc		Single Arc		Tandem Arc	
	Cu	Ni	Cu	Ni	Cu	Ni	Cu	Ni
BWCA	0	1	N/A	N/A	1	1	N/A	N/A
CEDC	N/A	N/A	N/A	N/A	1	1	N/A	N/A
WFDC	1	1	2	2	1	1	2	2
IPWDA	1	1	2	2	1	1	2	2
Surv. Welds	1	1	2	2	1	1	2	2

Table 7 - Weighting Factors used to Determine Best-Estimate Copper and Nickel

Based on the above methodology, best-estimate copper and nickel values were determined for each of the weld filler material heat numbers contained in the Farley 1 and 2 reactor vessel beltlines. The resulting best-estimate copper and nickel values for the weld filler materials are found in Table 1. Appendix A contains the detailed calculation of the best-estimate values for each of the Farley 1 and 2 beltline weld filler material heats.

The above described methodology is consistent with that described by NEI letter dated October 20, 1995.

Appendix A

Determination of Best-Estimate
Copper and Nickel

Heat Number: 33A277 (Copper Coated Electrode)

Analysis Source	Analysis Type	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor Cu	Weighting Factor Ni	Contribution to Best Estimate Cu	Contribution to Best Estimate Ni	Reference
Farley Surv. Weld	WFDC	0.14	0.19	Tandem Arc	2	2	0.28	0.38	WCAP-8810
Plant A Surveillance Weld	WFDC	0.175	0.149	Tandem Arc	2	2	0.35	0.298	See Table A-1b
D11326	WFDC	0.18		Single Arc	1	0	0.18	0	RVG-0000000385
D9711	WFDC	0.18	0.19	Tandem Arc	2	2	0.36	0.38	BGE 92-01, S1 Submittal
Plant B Weld	WFDC	0.208	0.167	Single Arc	1	1	0.208	0.167	See Table A-1c
Plant C Surveillance Weld	WFDC	0.223	0.164	Tandem Arc	2	2	0.446	0.328	See Table A-1a
D7948	WFDC	0.23		Tandem Arc	2	0	0.46	0	RVG-0000000219
D9217	WFDC	0.23		Single Arc	1	0	0.23	0	RVG-0000000122
D8371	WFDC	0.26		Single Arc	1	0	0.26	0	SIS-0048734407
D8601	WFDC	0.26		Single Arc	1	0	0.26	0	RVG-0000006987
D8778	IPWDA	0.26	0.17	Single Arc	1	1	0.26	0.17	SIS-0147938615
D7514	WFDC	0.27		Single Arc	1	0	0.27	0	RVG-0000006200
D8583	WFDC	0.27		Single Arc	1	0	0.27	0	RVG-0000006987
D8777	IPWDA	0.27	0.16	Single Arc	1	1	0.27	0.16	SIS-0147938615
D7986	WFDC	0.29	0.16	Tandem Arc	2	2	0.58	0.32	BGE 92-01, S1 Submittal
D7985	WFDC	0.29	0.16	Tandem Arc	2	2	0.58	0.32	BGE 92-01, S1 Submittal
D7629	WFDC	0.29		Single Arc	1	0	0.29	0	SIS-0000045842
D7947	WFDC	0.3		Single Arc	1	0	0.3	0	RVG-0000000219
D7416	WFDC	0.32		Single Arc	1	0	0.32	0	C-E Response to IEB 78-12
D7417	WFDC	0.32		Single Arc	1	0	0.32	0	C-E Response to IEB 78-12
D7565	WFDC	0.32		Single Arc	1	0	0.32	0	BGE 92-01, S1 Submittal
					28	15	6.814	2.523	

Best Estimate Copper = 6.814/28 = 0.24
Best Estimate Nickel = 2.523/15 = 0.17

TABLE A-1 - CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR WELD WIRE HEAT 33A277

Plant C Surveillance Weld Supplemental Chemical Analyses - Heat Number 33A277

Specimen	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor Cu	Weighting Factor Ni	Contribution to Best Estimate Cu	Contribution to Best Estimate Ni
Plant C Surveillance Weld - Pt 1	0.24	0.18	Tandem	2	2	0.48	0.36
Plant C Surveillance Weld - Pt 2	0.28	0.16	Tandem	2	2	0.56	0.32
Plant C Surveillance Weld - Pt 3	0.27	0.15	Tandem	2	2	0.54	0.3
Plant C Surveillance Weld - Pt 4	0.24	0.15	Tandem	2	2	0.48	0.3
Plant C Surveillance Weld - Pt 5	0.26	0.14	Tandem	2	2	0.52	0.28
Plant C Surveillance Weld - Pt 6	0.23	0.2	Tandem	2	2	0.46	0.4
Plant C Surveillance Weld - Pt 7	0.26	0.16	Tandem	2	2	0.52	0.32
Plant C Surveillance Weld - Pt 8	0.25	0.16	Tandem	2	2	0.5	0.32
Plant C Surveillance Weld - Pt 9	0.24	0.15	Tandem	2	2	0.48	0.3
Plant C Surveillance Weld - Pt 10	0.24	0.16	Tandem	2	2	0.48	0.32
Plant C Surveillance Weld - Pt 11	0.25	0.15	Tandem	2	2	0.5	0.3
Plant C Surveillance Weld - Pt 12	0.26	0.16	Tandem	2	2	0.52	0.32
Plant C Surveillance Weld - Pt 13	0.25	0.16	Tandem	2	2	0.5	0.32
Plant C Surveillance Weld - Pt 14	0.28	0.14	Tandem	2	2	0.56	0.28
Plant C Surveillance Weld - Pt 15	0.2	0.15	Tandem	2	2	0.4	0.3
Plant C Surveillance Weld - Pt 16	0.19	0.14	Tandem	2	2	0.38	0.28
Plant C Surveillance Weld - Pt 17	0.18	0.14	Tandem	2	2	0.36	0.28
Plant C Surveillance Weld - Pt 18	0.18	0.15	Tandem	2	2	0.36	0.3
Plant C Surveillance Weld - Pt 19	0.22	0.16	Tandem	2	2	0.44	0.32
Plant C Surveillance Weld - Pt 20	0.22	0.16	Tandem	2	2	0.44	0.32
Plant C Surveillance Weld - Pt 21	0.21	0.21	Tandem	2	2	0.42	0.42
Plant C Surveillance Weld - Pt 22	0.17	0.18	Tandem	2	2	0.34	0.36
Plant C Surveillance Weld - Pt 23	0.2	0.22	Tandem	2	2	0.4	0.44
Plant C Surveillance Weld - Pt 24	0.16	0.17	Tandem	2	2	0.32	0.34
Plant C Surveillance Weld - Pt 25	0.16	0.16	Tandem	2	2	0.32	0.32
Plant C Surveillance Weld - Pt 26	0.16	0.21	Tandem	2	2	0.32	0.42
				52	52	11.60	8.54

```
Best Estimate Copper = 11.60/52 = 0.223
Best Estimate Nickel = 8.54/52  = 0.164
```

TABLE A-1a-CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR PLANT C SURVEILLANCE WELD (HEAT 33A277)

Plant A Surveillance Weld Supplemental Chemical Analyses - Heat Number 33A277

Specimen	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor Cu	Weighting Factor Ni	Contribution to Best Estimate Cu	Contribution to Best Estimate Ni
Plant A Surveillance Weld - Pt 1	0.15	0.15	Tandem	2	2	0.3	0.3
Plant A Surveillance Weld - Pt 2	0.15	0.15	Tandem	2	2	0.3	0.3
Plant A Surveillance Weld - Pt 3	0.16	0.15	Tandem	2	2	0.32	0.3
Plant A Surveillance Weld - Pt 4	0.16	0.14	Tandem	2	2	0.32	0.28
Plant A Surveillance Weld - Pt 5	0.15	0.15	Tandem	2	2	0.3	0.3
Plant A Surveillance Weld - Pt 6	0.15	0.15	Tandem	2	2	0.3	0.3
Plant A Surveillance Weld - Pt 7	0.15	0.14	Tandem	2	2	0.3	0.28
Plant A Surveillance Weld - Pt 8	0.15	0.16	Tandem	2	2	0.3	0.32
Plant A Surveillance Weld - Pt 9	0.14	0.17	Tandem	2	2	0.28	0.34
Plant A Surveillance Weld - Pt 10	0.15	0.14	Tandem	2	2	0.3	0.28
Plant A Surveillance Weld - Pt 11	0.19	0.17	Tandem	2	2	0.38	0.34
Plant A Surveillance Weld - Pt 12	0.21	0.14	Tandem	2	2	0.42	0.28
Plant A Surveillance Weld - Pt 13	0.21	0.14	Tandem	2	2	0.42	0.28
Plant A Surveillance Weld - Pt 14	0.21	0.14	Tandem	2	2	0.42	0.28
Plant A Surveillance Weld - Pt 15	0.21	0.14	Tandem	2	2	0.42	0.28
Plant A Surveillance Weld - Pt 16	0.22	0.15	Tandem	2	2	0.44	0.3
Plant A Surveillance Weld - Pt 17	0.21	0.15	Tandem	2	2	0.42	0.3
				34	34	5.94	5.06

```
Best Estimate Copper = 5.94/34   = 0.175
Best Estimate Nickel = 5.06/34   = 0.149
```

TABLE A-1b - CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR PLANT A SURVEILLANCE WELD (HEAT 33A277)

Plant B Surveillance Weld Supplemental Chemical Analyses - Heat Number 33A277

Specimen	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor		Contribution to Best Estimate	
				Cu	Ni	Cu	Ni
Plant B Weld - Pt 1	0.24	0.15	Single	1	1	0.24	0.15
Plant B Weld - Pt 2	0.22	0.18	Single	1	1	0.22	0.18
Plant B Weld - Pt 3	0.23	0.14	Single	1	1	0.23	0.14
Plant B Weld - Pt 4	0.22	0.17	Single	1	1	0.22	0.17
Plant B Weld - Pt 5	0.25	0.16	Single	1	1	0.25	0.16
Plant B Weld - Pt 6	0.24	0.2	Single	1	1	0.24	0.2
Plant B Weld - Pt 7	0.22	0.15	Single	1	1	0.22	0.15
Plant B Weld - Pt 8	0.21	0.17	Single	1	1	0.21	0.17
Plant B Weld - Pt 9	0.19	0.13	Single	1	1	0.19	0.13
Plant B Weld - Pt 10	0.2	0.18	Single	1	1	0.2	0.18
Plant B Weld - Pt 11	0.23	0.16	Single	1	1	0.23	0.16
Plant B Weld - Pt 12	0.23	0.19	Single	1	1	0.23	0.19
Plant B Weld - Pt 13	0.22	0.15	Single	1	1	0.22	0.15
Plant B Weld - Pt 14	0.21	0.15	Single	1	1	0.21	0.15
Plant B Weld - Pt 15	0.21	0.15	Single	1	1	0.21	0.15
Plant B Weld - Pt 16	0.23	0.15	Single	1	1	0.23	0.15
Plant B Weld - Pt 17	0.19	0.19	Single	1	1	0.19	0.19
Plant B Weld - Pt 18	0.25	0.15	Single	1	1	0.25	0.15
Plant B Weld - Pt 19	0.18	0.17	Single	1	1	0.18	0.17
Plant B Weld - Pt 20	0.28	0.16	Single	1	1	0.28	0.16
Plant B Weld - Pt 21	0.2	0.19	Single	1	1	0.2	0.19
Plant B Weld - Pt 22	0.21	0.16	Single	1	1	0.21	0.16
Plant B Weld - Pt 23	0.19	0.2	Single	1	1	0.19	0.2
Plant B Weld - Pt 24	0.18	0.15	Single	1	1	0.18	0.15
Plant B Weld - Pt 25	0.18	0.18	Single	1	1	0.18	0.18
Plant B Weld - Pt 26	0.21	0.16	Single	1	1	0.21	0.16
Plant B Weld - Pt 27	0.2	0.2	Single	1	1	0.2	0.2
Plant B Weld - Pt 28	0.18	0.14	Single	1	1	0.18	0.14
Plant B Weld - Pt 29	0.19	0.14	Single	1	1	0.19	0.14
Plant B Weld - Pt 30	0.19	0.14	Single	1	1	0.19	0.14
Plant B Weld - Pt 31	0.21	0.16	Single	1	1	0.21	0.16
Plant B Weld - Pt 32	0.2	0.17	Single	1	1	0.2	0.17
Plant B Weld - Pt 33	0.17	0.14	Single	1	1	0.17	0.14
Plant B Weld - Pt 34	0.15	0.22	Single	1	1	0.15	0.22
Plant B Weld - Pt 35	0.2	0.16	Single	1	1	0.2	0.16
Plant B Weld - Pt 36	0.18	0.25	Single	1	1	0.18	0.25
				36	36	7.49	6.01

Best Estimate Copper = 7.49/36 = 0.208
Best Estimate Nickel = 6.01/36 = 0.167

TABLE A-1c - CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR PLANT B WELD (HEAT 33A277)

Heat Number: 5P5622 (COPPER COATED ELECTRODE)									
Analysis Source	Analysis Type	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor Cu	Weighting Factor Ni	Contribution to Best Estimate Cu	Contribution to Best Estimate Ni	Reference
D14146	WFDC	0.13		Single Arc	1	0	0.13	0	RVG-0000000109
D16288	WFDC	0.13	0.06	Single Arc	1	1	0.13	0.06	RVG-0000000207
D16199	WFDC	0.14	0.09	Single Arc	1	1	0.14	0.09	RVG-0000011794
D16287	WFDC	0.15	0.05	Single Arc	1	1	0.15	0.05	RVG-0000000208
					4	3	0.55	0.2	

Best Estimate Copper = 0.55/4 = 0.14
Best Estimate Nickel = 0.20/3 = 0.07

TABLE A-2- CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR WELD WIRE HEAT 5P5622

Heat Number: 6329637 (COPPER COATED ELECTRODE)									
Analysis Source	Analysis Type	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor Cu	Weighting Factor Ni	Contribution to Best Estimate Cu	Contribution to Best Estimate Ni	Reference
R2891	BWCA	0.08	0.11	NA	0	1	0	0.11	RVG-0000000240
D11271	WFDC	0.18		Single Arc	1	0	0.18	0	RVG-0000000111
D11314	WFDC	0.19		Tandem Arc	2	0	0.38	0	RVG-0000000114
D11020	WFDC	0.21		Single Arc	1	0	0.21	0	RVG-0000000240
D11213	WFDC	0.24		Tandem Arc	2	0	0.48	0	RVG-0000000190
					6	1	1.25	0.11	

Best Estimate Copper = 1.25/6 = 0.21
Best Estimate Nickel = 0.11/1 = 0.11

TABLE A-3 - CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR WELD WIRE HEAT 6329637

Heat Number: 83640 (NON-COPPER COATED ELECTRODE)

Analysis Source	Analysis Type	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor Cu	Weighting Factor Ni	Contribution to Best Estimate Cu	Contribution to Best Estimate Ni	Reference
D12745	WFDC	0.05		Single Arc	1	0	0.05	0	RVG-0000000168
D14090	WFDC	0.05		Single Arc	1	0	0.05	0	SIS-0000011071
D13964	WFDC	0.05	0.09	Single Arc	1	1	0.05	0.09	RVG-0000012068
D23725	WFDC	0.06	0.04	Single Arc	1	1	0.06	0.04	C-E Response to IEB 78-12
					4	2	0.21	0.13	

```
Best Estimate Copper - 0.21/4 - 0.05
Best Estimate Nickel - 0.13/2 - 0.07
```

TABLE A-4 - CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR WELD WIRE HEAT 83640

Heat Number: 90099 (COPPER COATED ELECTRODE)

Analysis Source	Analysis Type	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor Cu	Weighting Factor Ni	Contribution to Best Estimate Cu	Contribution to Best Estimate Ni	Reference
D8280	WFDC	0.09		Single Arc	1	0	0.09	0	SIS-0000052946
D8955	WFDC	0.17		Tandem Arc	2	0	0.34	0	SIS-0000010862
D9295	WFDC	0.17		Single Arc	1	0	0.17	0	RVG-0000006187
D9248	WFDC	0.18		Single Arc	1	0	0.18	0	ATI/WOG RPVDATA
D8954	WFDC	0.19		Single Arc	1	0	0.19	0	SIS-0000010247
D11313	WFDC	0.22		Tandem Arc	2	0	0.44	0	RVG-0000000112
D11302	WFDC	0.25		Single Arc	1	0	0.25	0	RVG-0000000107
D11027	WFDC	0.3		Single Arc	1	0	0.3	0	RVG-0000000242
					10	0	1.96	0	

```
Best Estimate Copper -  1.96/10 - 0.20
Best Estimate Nickel -          - 0.20   [Note 1]
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Notes: [1] Based on upper limit of nickel content for Type B-4 weld wire stated in Combustion Engineering report for Salem 1 and 2, dated November 1985.

TABLE A-5 - CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR WELD WIRE HEAT 90099

Heat Number: BOLA

Analysis Source	Analysis Type	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor Cu	Weighting Factor Ni	Contribution to Best Estimate Cu	Contribution to Best Estimate Ni	Reference
Supplier Analysis	CEDC	0.02	0.93	Manual Arc	1	1	0.02	0.93	RVG-0000004362
Farley 2 Surv. Weld	CEDC	0.026	0.88	Manual Arc	1	1	0.026	0.88	WCAP-11438
Farley 2 Surv. Weld	CEDC	0.03	0.9	Manual Arc	1	1	0.03	0.9	WCAP-8956
D18153	WFDC	0.03	0.9	Manual Arc	1	1	0.03	0.9	SONGS 92-01, R1, S1 Response
D18154	WFDC	0.03	0.91	Manual Arc	1	1	0.03	0.91	SONGS 92-01, R1, S1 Response
D18155	WFDC	0.03	0.95	Manual Arc	1	1	0.03	0.95	SONGS 92-01, R1, S1 Response
					6	6	0.166	5.47	

Best Estimate Copper = 0.166/6 = 0.03
Best Estimate Nickel = 5.47/6 = 0.91

TABLE A-6 - CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR WELD WIRE HEAT BOLA

Heat Number: HODA

Analysis Source	Analysis Type	Wt% Cu	Wt% Ni	Weld Type	Weighting Factor Cu	Weighting Factor Ni	Contribution to Best Estimate Cu	Contribution to Best Estimate Ni	Reference
Supplier Analysis	CEDC	0.02	0.96	Manual Arc	1	1	0.02	0.96	RVG-0000004556
					1	1	0.02	0.96	

Best Estimate Copper = 0.02/1 = 0.02
Best Estimate Nickel = 0.96/1 = 0.96

TABLE A-7 - CALCULATION OF BEST-ESTIMATE COPPER AND NICKEL VALUES FOR WELD WIRE HEAT HODA